(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 028 533**
A2

(12) # EUROPEAN PATENT APPLICATION

(21) Application number: 80303934.6

(51) Int. Cl.³: B 41 J 3/00

(22) Date of filing: 05.11.80

(30) Priority: 06.11.79 US 91862
26.09.80 US 188030

(43) Date of publication of application:
13.05.81 Bulletin 81/19

(84) Designated Contracting States:
DE FR NL

(71) Applicant: NCR Corporation
World Headquarters
Dayton Ohio 45479(US)

(72) Inventor: King, Paul L.
114 Catherine Street
Ithaca New York 14850(US)

(72) Inventor: Grimes, Joseph E.
221 Ridgedale Road
Ithaca New York 14850(US)

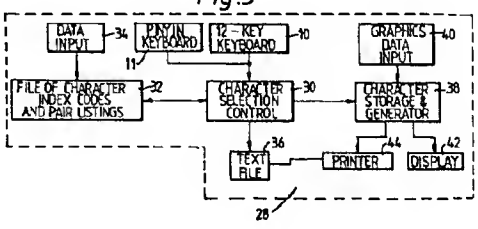
(72) Inventor: Cochran, Richard C.
111 Auburn Street
Ithaca New York 14850(US)

(74) Representative: Robinson, Robert George
International Patent Department NCR Limited 206
Marylebone Road
London NW1 6LY(GB)

(54) Method and apparatus for producing ideographic text.

(57) In a method and apparatus for producing ideographic texts, such as those utilizing Chinese characters, a twelva-key keyboard (10) permits construction of a shape identifier coda utilizing indicia which represent the shape of a character to be reproduced. Preferably, the four corners of the character are utilized to effect the coding. Alternatively, a phonetic identifier code utilizing a phonetic alphabet can be constructed to represent the character. The identifier code is used to select from a mamory file (32) all the characters corresponding to the keyad-in identifier code. If the word to be typed comprises a single character, means are provided for manually resolving ambiguities in the characters salected by the identifier code. If the word consists of two characters, means are provided automatically to resolve ambiguities in the word in accordance with permissible character pairings. If more than one possibla pairing axists, additional maans are provided for manually resolving ambiguities in the pairs. Means are provided for storing and/or displaying the unique character or character pair which results from the selection process, wherаby text material in symbolic language characters may be rapidly and accuratаly producad. Tha text material thus produced may be used to control the operation of a printing device (44).

Fig.5



EP 0 028 533 A2

Method and Apparatus For Producing Ideographic Text

This invention relates to methods of the kind for producing ideographic text material utilizing a keyboard having a plurality of keys carrying indicia related to characters to be produced.

A method of the kind specified is known from U. S. Patent No. 4,096,934 which relates to a method and apparatus for reproducing desired Chinese ideographs. According to the disclosure of said U. S. Patent, a computer is employed to store a catalogue of Chinese characters. The characters are retrieved by means of an indexing system in which an ideograph is identified by spelling the pronunciation and by using standard Chinese phonetic symbols to describe the geometry of the character of parts of the character or to describe meanings of the character. All the standard Chinese characters are described in this manner and this information is stored in the computer. However, a single phonetic word does not uniquely describe a single Chinese character, so a second sequence of standard Chinese phonetic symbols is provided to describe the shape or some descriptive characteristic of each character. To recover a specific character, then, two sequences of phonetic symbols are required. If this still does not identify the desired character, then additional sequences of phonetic symbols representing either the appearance of or the pronunciation of brush strokes or radicals must be encoded. This process, which requires plural encoding steps to recover a single character has the disadvantages of being extremely complex and time consuming.

It is an object of the present invention to provide a method of the kind specified wherein the aforementioned disadvantages are alleviated and a high degree of accuracy can be achieved.

Therefore, according to the present invention, a method of the kind specified is characterized by the steps of selecting one or more of said keys in sequence to provide an identifier code for

each desired character; calling up from memory means character information representing all the characters corresponding to the identifier code provided by the keyboard for each desired character; temporarily storing the called-up character information; determining if a difference exists between the number of characters desired and the number of characters represented in the temporarily stored character information; resolving any resulting ambiguities; and transferring output information representing the desired character to text storage means.

Embodiments of the invention will now be described by way of example with reference to the accompanying drawings, in which:-

Figs. 1A and 1B are diagrammatic illustrations of keyboards used with the system of the present invention;

Fig. 2 is a diagrammatic illustration of a pair of Chinese characters;

Fig. 3 is an illustration of the application of a four-corner shape identifier code used in the present invention;

Figs. 4a-4f illustrate a plurality of Chinese characters all having the same shape identifier codes;

Fig. 5 is a block diagram of a system for eliminating ambiguities in the selection of a Chinese character;

Figs. 6A and 6B combine to form Fig. 6, and comprise a more detailed block diagram of the system of Fig. 5;

Figs. 7A, 7B and 7C present a flow diagram of the method of the present invention;

Fig. 8 illustrates the relationship of Figs. 6A and 6B; and

Fig. 9 illustrates the relationship of Figs. 7A, 7B and 7C.

The aspect of typing ideograms, logograms or like characters that produces the greatest difficulty to both the typist and the designer of the typewriter is the problem of identifying the particular character desired. When the selection must be made from the 50,000 Chinese characters historically available, or even from among the 10,000 characters in current use, this identification

becomes a slow, time-consuming task. By the use of either or both of the keyboards illustrated in Figs. 1A and 1B, however, the identification and selection of a character for printing, typing, display or the like, is greatly facilitated. The keyboard 10 shown in Fig. 1A is a shape identification board which enables a typist to operate the system of the invention in a shape recognition mode by inspecting a character and producing a shape identifier code rapidly and accurately through the use of a "four corner" coding system. The keyboard 11, shown in Fig. 1B, is a pinyin (romanized alphabet) keyboard which enables a typist to operate the system in a phonetic typing mode by producing an identifier code based on the pronunciation of the character so that the typist who speaks the language can use the phonetic spelling of the character/word as the basis for typing. Either keyboard may be used to call up a given character, and if desired, the keyboards may be used interchangeably in typing a series of characters, so that the system may be operated in the shape recognition mode or the phonetic mode as desired by the typist. Although the present invention is illustrated as having both the phonetic and the shape recognition modes, it will be apparent that the system of the invention may be constructed with only one mode, if desired. However, of the two, the shape recognition mode represents the preferred embodiment of the invention, with the phonetic mode representing an alternative method of providing coded data representative of a character to be produced.

In accordance with the preferred embodiment, the individual keys on key pad 10 display ten basic stroke configurations which are found at the extremities of Chinese ideograms, and these stroke configurations are used to identify the character to be typed. This key pad may be a standard alphanumeric twelve-key keyboard, with ten of the keys carrying the Arabic numerals 0-9, and the two additional keys 12 and 14 carrying indicators for character delimiter functions, key 12 providing a comma (",") between

adjacent characters and key 14 providing an "end of word" or "print" indication. The Arabic numerals not only identify the keys 0-9, but are used for manual disambiguation, as will be described below. Although the key pad 10 is shown as a separate unit, it will be understood that, if desired, it can be integrated with a standard typewriter-style keyboard, either as separate keys or as an overlay. This may be conveniently done with a conventional computer input terminal keyboard.

The placement of the several stroke configurations on the various keys is determined by shape association, frequency of use, and the usual positions of the strokes in Chinese characters, so that there is a natural relationship between the keys and the characters that are to be typed. Thus, the stroke configuration on key 1 is the Chinese number 1; the configuration on key 7 looks like the Arabic numeral 7, and the configuration on key 8 is the Chinese number 8.

Among the seven remaining stroke configurations, those indicated on keys 5, 4 and 6, respectively, are the most frequently used, in descending order of frequency. Those are, therefore, placed on the keys which are the normal rest positions for the operator's fingers, so that the operator need not move his fingers in order to select those configurations. In addition to being frequently used, there are additional associations for the stroke configurations on keys 4 and 6. The configuration on key 4 is the Chinese number 10, which is pronounced "shi" in Mandarin Chinese. The number 4 is pronounced "si" in Mandarin. Although this pronunciation of the numbers 4 and 10 is similar, it is even more so for southern Chinese dialects, particularly Taiwanese, which does not have a retroflex sibilant in its dialect. For the latter dialect, both the numbers 4 and 10 are pronounced "si" in Mandarin, with only a difference in tone, and in common speech the two numbers often are confused. This phonetic affinity is used in the keyboard 10 by placing the stroke configuration for the

number 10 on key 4, thus enabling an operator to quickly learn the location of the particular configuration, and facilitating the use of the keyboard.

The frequently used configuration on key 6 of pad 10 is one which often appears on the right side of a character, and thus there is a positional association between the location of the stroke on the character and its location on the keyboard.

The remaining four stroke configurations are the least frequently used of the ten selected configurations. The one illustrated on key 9 always appears at the top of a character, and thus is placed on the top line of keys. Similarly, the configuration on key 3 is often at the lower right portion of a character while the configuration on key 2 is usually somewhere in the bottom half of a character.

The least frequently used stroke configurations is that illustrated on the "0" key. This key is furthest from the most frequently used key, and thus provides a double association for the typist: the frequency of use is least, so it is on the lowest number, and it is furthest in location from key 5. In addition, this configuration represents a shape that is usually found in the bottom portion of a character.

The configurations shown on keyboard 10 are used by a typist to identify portions of a character to be typed, so as to call that character from the processing system memory. The process of identification is based on a "four-corner" system, wherein the ten stroke configuration types described above are used to produce a code which corresponds to the character. On the basis that a Chinese ideogram is basically square in appearance, a four-digit code can be produced from the above-described key pad 10 by identifying various stroke shapes in the four quadrants of a character: the upper left, upper right, lower left, and lower right, and by depressing the corresponding keyboard keys in that sequence. This produces a series of keyboard signals,

which for convenience may be referred to as a series of corresponding keyboard numbers, which constitute an identifier code for the character. When this code is determined by the shape of the character, it will herein be referred to as a shape identifier code.

One possible four-corner system for identifying ideograms requires a four-digit code number to identify every character, whether or not that character had four identifiable corners. In the case where there is not an identifiable stroke configuration, such system requires insertion of a "0" (or null); however, since the 0 key also represents a specific stroke configuration, such four-corner system has a built-in ambiguity. Further, since such system requires a null identifier, the use of such system results in the generation of numerous unneeded signals. In fact, in one sampling it was found that a null signal appeared in about 53% of the characters, and thus introduced ambiguities or extra key strokes in a majority of characters to be typed. In the present embodiment, however, the null key stroke of such four-corner system is eliminated, so that the zero key is only used to provide identification for a stroke shape actually appearing in the character to be typed. Thus, for example, the Chinese character "一" has all four corners covered by a single stroke; however, the above-discussed four-corner system requires the typist to identify it with four key strokes: a "1" and three null indicators, to provide a code number of 1000. Under the presently preferred four-corner system, the character may be identified by a "1" key stroke alone.

The preferred four-corner encoding system thus has the advantage that while simple characters can be identified by as few as one code number, more complex characters have additional identifier code positions available, and this increase in stroke categories serves to reduce the ambiguities which occur as a result of the typing process. Further, the typist need not

remember to add null zeros when reading an ideogram; it is only necessary to identify the shapes that are actually present in the character so that, on the average, fewer key strokes are required in typing the characters.

An example of the use of the stroke configuration displayed on the key pad 10 of Fig. 1A to encode Chinese ideograms is illustrated in Figs. 2 and 3, wherein the Chinese characters "dì" and "fāng" are diagrammatically illustrated. These characters may be translated into English as "land" and "area", respectively, and when used together as the single, two-syllable word (or word phrase) difang, may be translated as meaning "place". The character "dì" may be identified by the stroke configurations indicated within the dotted circles 16, 16, 18 and 19 in the four quadrants of the character, and a comparison of these configurations with thos on the keyboard 10 illustrates that the character may be identified by the new four-corner system of encoding by striking keys, 4, 4, 1 and 1 in sequence, giving the shape identifier code 4411 for that character. It will be understook that the illustrated numeric code is exemplary of the presently preferred form of this invention, and that other numerical, alphabetical or symbolic codes may be provided, the particular indicia used being a matter of choice and in part dependent upon the particular keyboard being used.

The character "fāng" similarly may be encoded through use of the preferred four-corner system, wherein the upper left, lower left, and lower right quadrant configurations 20, 21 and 22, are respectively represented by the keys 9, 5 and 5, respectively. Note that no stroke configuration need be identified for the upper right quadrant, and that no filler key stroke is required; thus, no ambiguity is created by the encoding process. The identifier code 955 thus represents the character "fāng", as illustrated in Fig. 3.

When typing Chinese characters by means of the electronic typewriter system of the present embodiment, in the shape

recognition mode, the typist looks at the character to be reproduced, and by use of the preferred four-corner system described above, strikes selected keys on keyboard 10 in sequence to produce an identifier code for that character. The keyboard produces corresponding signals which are fed into the data processing system (to be described) to call up the character so selected. Although the identifier code selected by the operator for a particular character will often call up the desired character, the complexity of the Chinese ideogram, the manner in which it is constructed, and the large number of characters in the Chinese language result in a large number of characters which closely resemble each other, and it often happens that a given identifier code will call up more than one character from the data processing system; i.e., will produce an ambiguity. An example of this ambiguity is illustrated in Fig. 4, with respect to the character "fāng".

As noted, the character "fāng" of Fig. 2 may be identified in the preferred four-corner system by the shape identifier code 955. However, this code number only refers to peripheral characteristics of the ideogram, and a number of other characters having distinct configurations and meanings have the same identifier code. Figs. 4a-4f illustrate six ideograms having the identifier number 955, as follows:

Fig. 4a: yù, meaning "education" (Telegraph Code 5148);

Fig. 4b: fāng, meaning "area" (Telegraph Code, 2455);

Fig. 4c: dì, meaning "emperor" (Telegraph Code 1593);

Fig. 4d: gāo, meaning "height" (Telegraph Code 7559);

Fig. 4e: shāng, meaning "commerce" (Telegraph Code 794);

Fig. 4f: shì, meaning "marketplace" (Telegraph Code 1579).

It is noted that the "Telegraph Code" number is the number assigned to each character in the standard Telegraph Book that has been in use for many years to provide means for identifying particular Chinese characters.

When the system of the invention is used in the phonetic mode, the keyboard 11 illustrated in Fig. 1B may be used. This may be a standard typewriter-style keyboard, and conveniently is a conventional computer input terminal keyboard. All of the alpha symbols, with the exception of the letter "v" are used, and thus no overlay or modification of the board is needed. However, since the phonetic pinyin system utilizes superscripts as well as alpha symbols, standard keys carrying the standard symbols "-", "/", "=", and "\" may be used to represent the first, second, third and fourth tones, respectively.

Although the tone marks in standard pinyin transcriptions are written as superscripts over syllabic vowels, in acccordance with the present invention the pinyin words are typed on keyboard 11 simply by typing the needed tone mark in sequence after the spelled syllable is typed. Thus, for example, a pinyin syllable such as "shī" is typed on keyboard 11 as "shi-", the syllable "dì" is typed "di\" and the syllable "fāng" is typed "fang-".

The pinyin alpha symbols and tone marks serve the same function as the shape identifiers of key pad 10, in that they produce an identifier code which corresponds to the ideographic character to be typed. In the case of the key pad 10, the identifier code is a series of numbers (e.g., 4411 and 955), which correspond to the shape of the character, while in the casc of keyboard 11, it is a series of alpha and tone symbols which correspond to the sound, or pronunciation of the character.

Although the identifier codes produced in accordance with this invention do not themselves introduce ambiguities, a given code may call up more than one character from the systcm, and accordingly, both manual means and automatic means for

disambiguating the identified characters are provided. These means take advantage of the fact that while a Chinese ideogram represents a single syllable in the language, many Chinese words consist of two characters in a pairing to make a compound, or word phrase. It has been found in accordance with the present invention, that by typing these compound word pairings in sequence, most of the ambiguities due to similarities in shape or pronunciation can be eliminated. Thus, for example, if only one of the many characters in Fig. 4 identified as 955 can be paired with only one of the characters which might be identified as 4411 (Fig. 3), then when the typist calls for the pair 4411, 955, the pairing of Fig. 3 will be uniquely identified, thus eliminating the ambiguities that would otherwise exist for 4411 standing alone and for 955 standing alone. The same pairings exist, of course, when the identifier code is based on pinyin instead of shape characteristics.

It is possible that for some identifier code pairings there will still be ambiguities, since there are some identifiers which call up multiple Chinese character pairings. When this occurs, means are provided to display the multiple pairings in sequence, for manual disambiguation. This manual disambiguation is also available when a single character is to be typed, where automatic disambiguation cannot be used. The manual operation provides a rapid display of the various choices available to the typist, who may then select the desired character for printing or storage. This allows the typist to proceed quickly to the next character to be typed, enabling the typist to achieve typing speeds not previously possible.

The system of the present invention is disclosed in block diagram form in Fig. 5, which illustrates at 28 a data processing system having a character selection control logic section 30 (to be described) which is operated under the control of the keyboards 10 and 11 shown in Figs. 1A and 1B. The control logic

responds to instructions from either keyboard to call up the desired characters from an addressable storage section or memory 32, which may, for example, be a disc or other read-only memory. The memory 32 receives, by way of data input 34, information files which relate specific Chinese characters to specific identifier code indicia, so that the typing of shape or sound identifiers on keyboards 10 or 11 will produce identifier codes which will cause logic section 30 to call up, or retrieve, the corresponding character or characters. Preferably, each character has a unique index code by which it is catalogued in storage section 32. Conveniently, the Telegraph Code may be used for this purpose, although other index codes may be used.

Also stored in section 32 is the pairing information for each character, listing the other characters with which it may be paired to form a two-syllable word. In this listing, the character is considered to be the first of a pair, with the pairing information identifying which characters may be used as a second syllable. Thus, when the shape identifier code 4411 ("dì" in Fig. 2) is used to call up a character, section 32 provides a listing, by index code (here, the Telegraph Code) of those characters which have the identifier number 4411, together with a listing, by index code, of characters which might be paired with the selected characters. Thus, 4411 calls up the following information:

Table I

Identifier Code	Telegraph Index Code	Pairings (Telegraph Index Code)
4411 :	966	(7240, 7, 31, 143, 690, 1601, 2455, 2975, 3810, 4122, 4318, 3808, 528, 7191, 7820)
	5413	(5413)

Note that the character having Telegraph Code 966 can be paired

with fifteen other characters, while the character having Telegraph Code 5413 can only be paired with itself.

The file section 32 similarly contains for the identifier number 955 the following information:

Table II

Identifier Code	Telegraph Index Code	Pairings (Telegraph Index Code)
955 :	5148	
	2455	(3127, 4104, 7240, 2973, 143, 686, 189, 1709, 11, 2088)
	1593	(79, 455, 948, 1004, 1446, 3769, 6757)
	7559	(1129, 5281, 2841, 3808)
	794	(86, 5307, 756)
	1579	(6, 198, 90, 1034, 1627, 1869, 2398, 3127, 5116, 6133, 7024, 7240, 7333)

In similar manner the phonetic identifier codes (e.g., "di\" or "fang-") produced by keyboard 11 will cause the logic control 30 to call up any character or characters listed in file 32 as having the same phonetic code. This will result in a listing, by Telegraph Code, of all characters which sound like the typed syllable, together with their possible pairings. It will be apparent that the list of characters called up by the phonetic identifier code may differ from the list called up by the shape identifier code, even though the typist is seeking to type the same ideogram. Furthermore, the pairing lists of index codes and pairings produced by either method will contain the desired ideogram or ideogram pair, so that the disambiguation of the present embodiment (to be described) will produce the desired character or character pair.

When the character selection control logic 30 to be described has been operated to select the desired character or characters

from file section 32 and has eliminated any ambiguity, the selected characters are stored in a text file section 36 for printing, storage, or both.

To permit the system to generate the Chinese characters selected by the typist, a character storage and generator section 38 is provided. This section is a conventional character generator such as that shown, for example, in U.S. Patent No. 3,936,664, which may receive graphic information from a graphics data input device 40. This data input may be from a pen tracer device for direct graphical input, from an optical scanner for producing digital representations of graphical information, or from any other conventional graphics data source which will enable the system to store in section 38 the information required to allow generation of any Chinese characters selected by logic section 30.

The character generator 38 produces an output to a display unit 42 and to a printer 44 to produce the required characters. The display unit may be, for example, a cathode ray tube at the typist's table for visual display of the characters being selected. This enables the typist to verify the selection and to compare it with the original manuscript from which the characters are being typed. The display also aids the typist in manual disambiguation. The printer 44 may be a conventional dot matrix printer for producing a printed copy of the text being typed after disambiguation has been completed.

In a preferred form of the invention currently being implemented, the data processing system utilizes apparatus such as a PDP-11/40 model computer manufactured by Digital Equipment Corporation. The keyboard 10 is a conventional 12-key pad which is used in conjunction with the data input keyboard 34 of the PDP-11/40, the keyboard 11 may be a part of the data board 34, the graphics input device is a graphics tablet manufactured by Talos Systems, Inc., the display unit 42 is a Tektronix Model 4013 CRT display associated with the PDP-11/40, and the printer is a

Versatec Model 1200A Printer/Plotter manufactured by Versatec, a division of Xerox Corporation.

A more detailed description of the system of Fig. 5 is provided in the block diagram of Fig. 6, which incorporates Figs. 6A and 6B, and to which reference is now made. In this block diagram, the elements of Fig. 5 are similarly numbered, and thus keyboards 10 and 11, the random access memory section or file 32 for storing character codes and pairings, the selection control circuit 30, the text file 36, the graphics data input 40, the display 42, and the printer 44 are all illustrated in Fig. 6.

The character selection control 30 incorporates a pair of identifier storage buffers 50 and 52 which receive from keyboards 10 and 11 the identifier codes for the characters to be typed. Where a single character is being typed, the identifier code is fed to buffer 50, but where a two-syllable word is being typed, the first syllable is entered in buffer 50 and the second syllable is entered in buffer 52. The characters are entered by first typing on the keyboard the identifier code for the first character which, in the example of Fig. 3, would be the shape identifier code number 4411. If this character is to be followed by a second character to form a two-syllable word, a comma (,) is typed on key 12 of keyboard 10, the "," being the symbol for the space between characters in a pair. Thereafter, the identifer code for the second character, 955 in the example, is typed and this is followed by depressing key 14 on the keyboard which carries the "print" symbol and which serves as the delimiter which is used to indicate either the end of a single character or the end of a pair of characters. It should be noted that this print symbol is used for both the shape and the phonetic identifier codes, and thus may be provided on keyboard 11 if desired.

Upon depressing key 14, the first identifier code is entered in buffer 50 (Fig. 6A) and if there are two codes, the second identifier code is entered in buffer 52. These buffers provide

outputs on lines 54 and 56, respectively, to the memory file 32 to call up the information located at the addresses specified by these two identifiers. The file 32 transfers by way of lines 58 and 60 the data corresponding to the first identifier code to a storage buffer 62, transferring to buffer 62 the index codes and pair codes for all of the characters which correspond to the first identifier code. In this instance, the identifier code for the first character calls up the information indicated in Table I hereinabove and stores that information in buffer 62. In similar manner, the identifier code for the second character calls up the data from Table II hereinabove and feeds that data by way of lines 58 and 64 to storage buffer 66. This storage buffer receives the index codes corresponding to the selected characters, but since the pairs information for the second character is not required for resolving ambiguities, pairs information need not be included.

A suitable logic circuit 68 is provided to sense whether the data entered by keyboards 10 and 11 represents a single character or a two-character word. If only a single character (simplex) word is entered, there is no need for the pairs information stored in buffer 62; only the index codes therein are needed to identify the character to be typed. The index codes representing each of the characters which correspond to the identifier code supplied by the keyboards 10 and 11 are fed by way of line 70 through gating means 72 to line 74 and thence to a "pick list", or automatic selection buffer 76. Gate 72 transfers this index code information to the pick list when the number of character identifier codes (n) entered in the storage areas 50 and 52 is equal to one (n=1). When two sets of character identifier codes are entered (n=2), a different procedure is followed which will be discussed below. The output of logic network 68 is applied by way of lines 78 and 80 to gate 72 and is also applied by way of lines 78 and 82 to a second gate 84, the latter being operated when an identifier code representing only a single character is

received from the keyboard 10 or 11 to transfer the data from the pick list buffer 76 by way of lines 86 and 88 to a selector logic network 90.

When only one character is to be typed (n=1), the selector logic 90 receives the first index code from the pick list buffer 76 and determines if it is the only one. If only one index code is in that buffer, it is transferred immediately to the text buffer 92 (Fig. 6B) by way of line 94 and to a display buffer 96 by way of line 98. The data in display buffer 96 then activates the character generator 38 by way of line 100 and the display unit 42 by way of line 102 to provide a visual display of the character. Transferring the index code to the character generator 38 calls up the specific character which is identified by that index code and the typist may then compare the displayed character with the character from the manuscript material being typed to determine whether the system has produced the correct Chinese ideogram. When only one index code is received by the selector logic, the data in text buffer 92 is automatically transferred to the text file 36 by way of line 104 for storage and for printing. If the character is to be printed, the data in the text file activates the character generator 38 by way of line 106 to generate data relating to the printing of the selected character, which information is supplied by way of line 108 to printer 44. An appropriate format control may be provided for the printer by way of format control circuit 110 which is activated by an output on line 112 from the text file and which controls the printer 44 by way of line 114.

If the identifier code for the character to be typed calls up a plurality of index codes for storage in the pick list buffer 76, the selector logic 90 selects ("picks") the first one in the list, transfers it to the text and display buffers 92 and 96, as described above and displays the corresponding Chinese ideogram. If the typist wishes to use that character, the keyboard 10 is operated, for example by depressing the "1" key followed by key

14 (the "print" key) to transfer the selected index code to the text file for printing or storage of the corresponding character. If the first index code does not display the desired character, the typist depresses only the key 14 (for example), which produces a signal on line 114 to cause the selector logic to sample all of the remaining index codes in the pick list buffer 76 and to transfer them sequentially and repetitively to the text and display buffers 92 and 96. This causes the characters corresponding to the remaining index codes to be displayed for visual selection by the typist. The typist then depresses the key or keys on keyboard 10, or equivalent keys on keyboard 11, which have numerical values that correspond to a desired selection from the displayed list, with that number being followed by the print command of key 14 or its equivalent. Thus, for example, if nine index codes are displayed, and the operator wishes to select the fifth one in the list, he depresses key 5, followed by key 14 to transfer the fifth character in the list to the text file 36.

To facilitate the foregoing selection process, the file 32 normally contains the index codes corresponding to any given identifier code in the order of most frequent use, so that when the index codes are transferred to the pick list buffer 76, the first one on the list will be the one that is most likely to be the desired character. This results in a considerable saving of time if there is an ambiguity to be resolved.

In the event that the Chinese word being entered by way of keyboard 10 or keyboard 11 consists of two characters, so that two identifier codes are entered into the buffers 50 and 52, the index codes of all of the characters which correspond to each of these two identifiers will be called up and stored in buffers 62 and 66, respectively. The control circuit 30 will then proceed to determine whether any ambiguities exist, and if so to resolve them. This is accomplished by means of a matching network 120 (Fig. 6A).

The matching network 120 is connected to the output of storage buffer 62 by way of lines 70 and 126 and is connected to the output of storage buffer 66 by way of line 128. The circuit scans the contents of buffers 62 and 66 to match the index codes in each of these buffers, creating a series of index code pairs which are supplied by way of line 130 to the pick list buffer 76. Thus, the matching network 120 selects the first index code stored in buffer 62 and matches, or pairs, it in turn with each of the index codes stored in buffer 66 to create a first series of index code pairs, which are then stored in the pick list buffer 76. The matching network 120 then selects the second index code (if any) in buffer 62 and matches it in turn with each of the index codes in buffer 66, creating a second series of index code pairs which also are stored in pick list 76. The matching circuit 120 continues in this manner until each of the index codes in buffer 62 is paired with each of the index codes in buffer 66 and these index code pairs are all listed in the pick list buffer 76. The pick list buffer 76 then contains a complete listing of all of the possible combinations of index codes which can be derived from the two identifier codes selected by the typist.

The index code pairs stored in pick list buffer 76 are supplied one at a time by way of lines 86 and 132 to one input of comparator 122. This comparator then compares each index code pair on line 132 with the pairs information contained in the storage buffer 62 and fed to the comparator 122 by way of line 134. In this way, all of the possible index code pairings listed in the pick list 76 are compared with the permitted index code pairings previously established for each of the characters selected by the identifier code for the first character in a word pair. Each time a possible pair on line 132 is found to correspond to a permitted pair on line 134, that pair is immediately transferred by way of line 136 to the significant pair storage buffer 124 to indicate a "hit".

After all of the possible pairs in buffer 76 have been compared to all of the permitted pairs for each of the index codes in buffer 62, the selector logic circuit 90 scans the pair storage buffer 124 to determine whether any hits have been registered and if so, whether there is more than one hit. If only a single pair is stored in buffer 124, the selector logic 90 immediately supplies that pair of index codes to the text buffer 92, to the text file 36 for storage or for printing, and to the display buffer 96 for visual display on unit 42 of their corresponding characters to permit visual inspection by the typist. When this occurs, the system has successfully resolved all ambiguities automatically to provide extremely rapid typing of the desired character pair.

If the pair storage buffer 124 contains no pairs, the selector logic 90 may be activated to display the first pair of index codes stored in the pick list buffer 76. If that pair is not accepted by the typist, then the selector logic scans each of the other pairs in buffer 76 and displays them for visual inspection by the typist and manual selection by way of a keyboard entry, as discussed above, for manual resolution of the ambiguity.

If more than one pair of index codes is present in the storage buffer 124, the selector logic 90 provides manual resolution of this ambiguity, again in the manner described above, by selecting a first pair from buffer 124 for display, and if that is not the pair desired by the typist, thereafter displaying the remaining pairs in the buffer 124 for manual selection. If none of the foregoing procedures produce the desired character or character pair, then either the typist has misidentified the desired character, or the data file does not carry that character.

Although the selection control circuit 30 is illustrated in diagrammatic form in Fig. 6, it will be understood that each of the components thereof is conventional and may be activated by conventional switching or logic circuits. Thus, for example, the matching circuit 120 may simply be a conventional stepping

circuit which receives inputs from two sources by way of lines 126 and 128 and steps through one source completely for each step of the other source, producing an output on line 130 for each step. Similarly, the comparator 122 is a conventional circuit which receives data corresponding to specified index code pairs, determines whether the two inputs are identical and, if so, transfers the data to buffer 124. The selector logic 90 may be a conventional multiplexing unit which sequentially selects one of a multiplicity of inputs for transfer to a single output which is then supplied to the buffers 92 and 96.

The method of resolving ambiguities in the typing of symbolic graphical characters such as Chinese ideograms by the use of the system described with respect to the preceding figures is illustrated diagrammatically in Figs. 7A, 7B and 7C which represent a flow chart for the circuitry of Figs. 6A and 6B. As indicated in block 150, the first step in the process is for the typist to enter into the system by means of either the keyboard 10 or the keyboard 11 one or two coded identifiers selected in accordance with the four-corner stroke configuration of the character or characters to be typed, or selected in accordance with the phonetic spelling of such character or characters, or selected in accordance with a combination of these, i.e., with some characters being selected phonetically and others by their shape. The two modes are interchangeable, not exclusive, so that if desired each character of a two-syllable word can be selected differently. Upon entry of this information by the typist, the system calls up the index codes and pair lists for the first identifier, as indicated in block 152, and determines whether there is a second identifier, as indicated in block 154. If there is no second identifer, the identifier count is set to one, as indicated in block 156, and the process proceeds with the selection of all the index codes for the first identifier, as indicated by blocks 158, 160, 162 and 164. If a second identifier code is entered, the system first registers

that fact and then calls up the index codes for the second identifier, as indicated in block 166, before proceeding.

When there is a second identifier, the first index code for the first identifier is selected, as indicated in block 158, and the system then selects the first index code for the second identifier, as indicated in block 168, rather than immediately proceeding to select all of the remaining index codes for the first identifier. Upon selection of the first index code for both the first and second identifiers, the pair is transferred to the pick list selection buffer 76 as indicated in block 170 and 172. This process is the function of the matching network 120 of Fig. 6A.

The next step is to compare this pick list entry with each of the pair listings for the first identifier, in accordance with block 174. This is the function of the comparator 122 in Fig. 6A. If the selected pair corresponds with one of the permissible pairs in the pair listing, thereby indicating that this pair might be the one that is desired by the typist, this pair is transferred to the significant pair storage buffer (referred to as the "hit list"), as indicated in block 176. Thereafter, the next index code for the second identifier is selected, as indicated by block 178, it is matched with the first index code for the first identifier, and this new pair is placed in the pick list buffer 76 for comparison with the pair listings, as before. This process continues until all of the index codes for the second identifier have been paired with the first index code for the first identifier.

When as indicated by block 170, no additional index codes are available for the second identifier, the second index code for the first identifier is selected in accordance with block 164 and that second index code is compared with the index codes for the second identifier in accordance with blocks 168, 170, 172, 174, 176 and 178. Thereafter, block 164 selects the next index code for the first identifier and the process is repeated until all of the index codes for the first identifier have been matched with all of the index codes for the second identifier, all of the matched

pairs have been compared to the pair listings for the first identifier, and all significant pairs have been stored in the significant pair storage buffer 124.

It will be seen that if only one identifier has been entered into the system (n=1), then all of the index codes for the first identifier are entered in the pick list buffer 76. Similarly, if (n=2), all of the possible pairs of index codes for the first and second identifiers are entered in the pick list 76 and further, these are compared with the permissible pair listings for the first identifier and any matchups (or hits) are stored in the significant pair storage buffer 124. The system is then ready to proceed to the selection process, which results in the final selection of the desired character or characters in accordance with the procedures of Fig. 7B.

Considering first the situation where only a single identifier has been entered, the first step in the selection process is to scan the pick list buffer 76 to determine whether a single index code has been selected, as indicated by block 180 (Fig. 7B). If so, that index code is transferred to the text and display buffers 92 and 96, in accordance with block 182 (Fig. 7C), for visual inspection by the typist and the process is complete, as indicated by block 184. In this case, the stroke configuration identifier entered by the typist will have correctly identified a single character which is the one desired by the typist, and that character can then be printed or stored, as desired.

If there is not a single selection in the pick list buffer 76, the steps of blocks 186, 188 and 190 are followed. In this case, the first entry in the pick list is selected and displayed for visual inspection by the typist and if the typist accepts that first entry, it is transferred to the text and display buffers 92 and 96 in accordance with block 182. If, however, the first entry is not accepted, the remaining entries are displayed, and if the typist accepts one of these, the accepted entry is transferred

to the text and display buffers. Again, if none of the entries are accepted by the typist, there is no transfer of data to the text and display buffers, and the process is completed.

If no entries show up in the pick list 76, indicating that the identifiers failed to call up a corresponding character index code, there is nothing to be displayed and the process is complete, as indicated by block 192.

Where the typist has entered two identifiers, the selection process of Fig. 7C is followed. The first step in this process is indicated by block 194, wherein the significant pair storage buffer (124 in Fig. 6A) is scanned to determine whether there is only a single entry. If so, the matching and comparing procedures carried out by the matching network 120 and the comparator 122 have successfully and automatically resolved any ambiguities in the typing process, and this single entry can then be transferred to the text and display buffers 92 and 96 indicated in block 182, thereby completing the typing of those two characters.

If more than one pair of index codes is found in the pair storage buffer 124, as indicated by block 196, the first pair is selected and presented to the typist for visual inspection, as indicated in block 198. If that first pair is accepted, it is transferred to the text and display buffers 92 and 96 in accordance with block 182. If that first pair is not accepted, however, the remaining pairs from the pair storage buffer are presented for inspection, and if the typist accepts one of those later pairs, as indicated by block 200, the accepted pair is transferred. Again, if the typist does not accept any of these later pairs, the process is complete.

Finally, if inspection of the pair storage buffer 124 reveals no significant pairs stored therein by the comparator process, as indicated in block 202, the system operates to allow the typist to duplicate the process previously carried out by the

comparator 122. Thus, in accordance with block 204, the first pair placed in the pick list buffer (76 in Fig. 6A) is selected and the typist determines whether to accept that first pair. If it is accepted, it is transferred to the text and display buffers 92 and 96. If it is not accepted, then in accordance with block 206, each of the following pairs in the pick list 76 are selected in turn and if the typist accepts one of those pairs, it is transferred to the text and display buffers. If none of these pairs is accepted, the character identification process is complete for the selected identifiers.

From the foregoing it will be seen that a new and unique procedure for identifying Chinese or like characters by selected stroke configuration and/or phonetic spelling is provided. Because of the recognition that certain characters appear in pairs, the ambiguities otherwise inherent in the identification process can be eliminated or at least reduced in number so that if a manual selection of characters must be made, the number to be considered is greatly reduced. In this way, the speed of typing ideographic characters can be high.

EXAMPLE 1

The operation of the present system for a single Chinese character having a four digit identifier may be illustrated as follows:

If the word to be entered is "dì", translated "land", keys 4411 on the keyboard 10 are depressed, since those keys carry shape configurations which most nearly resemble the four quadrant shapes of the character "dì", as shown in Fig. 3.

As illustrated in Table I hereinabove, the conventional Telegraph Code is used in the presently preferred embodiment of the invention as the index code for the specific Chinese characters, with each identifier number serving to call up all characters having the peripheral shape configurations represented by this particular keyboard entry. Thus, the identifier 4411 calls up from the system storage file the characters represented by

the index (Telegraph) codes 966 and 5413 (see Table I), plus the pair listings for each, and these are stored in the first identifier storage buffer 62.

Because this example assumes that only a single character identifier is involved, the index codes 966 and 5413, but not the pair listings, are transferred to the "pick list" selection buffer 76, and the character represented by the first index code 966 is displayed. This character is the word "dì" (as established by the Telegraph Code book, for example), which the typist accepts. Accordingly, the typist adds the index code 966 to the text buffer, and goes to the next character to be typed.

EXAMPLE 2

The operation of the system in handling another single identifier representing, for example, the word "fāng", translated "area", may be illustrated as follows:

From Figs. 2 and 3, it will be seen that the shape identifier code which represents the stroke configuration for "fāng" is 955, only three code numbers being needed since the shape of the character is such that there is no peripheral stroke in the second quadrant. In the present syste, it is not necessary to use a filler zero in the identifier. As shown in Table II above, the shape identifier code 955 calls up six characters which have similar peripheral configurations (see Figs. 4a-4f), which characters are represented by the index codes 5148, 2455, 1593, 794 and 1579, taken from the Telegraph Code book. These index codes, accompanied by their pair listings, are transferred to the buffer 62, and the index codes only are then transferred to the pick list selection buffer 76, since pair listings are not required for single character words.

The fact that six characters have been called up by a single shape identifier represents an ambiguity to be resolved. Disambiguation is accomplished by first displaying the character represented by the index code 5148, which is illustrated in Fig. 4a.

If this is not the desired character (and it is not in the present example), it is rejected by the typist, and the selector logic then displays the five characters represented by the remaining five index codes in buffer 76. These are the characters of Figs. 4b-4f.

If the typist decides that the first of these characters (Fig. 4b) is the desired one, the number "1" is indicated by the typist on the keyboard, and when the "print" button is pressed, the index code 2455 is stored in the text buffer 92.

Even though ambiguities are present in both Example 1 and Example 2 which are not automatically resolved, it will be seen that the present system has greatly reduced the number of characters displayed to the typist for manual selection, and the speed with which the desired character can be selected and typed is thereby greatly enhanced.

EXAMPLE 3

The use of the pair listings in the automatic resolution of ambiguities may be illustrated as follows:

The character pair "dì fāng", translated "place" is to be typed, using the system in the shape recognition mode. The typist first inspects the character "dì", and enters the identifier 4411 on the keyboard 10, this coded identifier being selected by inspection and recognition of the pripheral stroke configurations. The typist recognizes that the next character is part of a Chinese two-syllable word, or compound word, so the delimiter ", ", is then entered by depressing key 12 on the keyboard, and the next character of the two-syllable word is inspected and its corresponding identifier 955 entered by the keyboard. The recognition of a Chinese compound requires that the typist be familiar with the Chinese language.

The index codes 966 and 5413 for the first character, together with their permissible pair listings (i.e., the listing of characters with which the first character may be paired to form a compound) are entered in buffer 62, and since there are two

characters, the index codes for the second character, i.e., code numbers 5148, 2455, 1593, 7559, 794 and 1579, are entered into buffer 66. Since these index codes represent the second character of a word-phrase, their pair listings are not required, and thus are not entered in buffer 66.

The matching network then pairs the index codes, to provide the following list of possible pairings:

966	5148
966	2455
966	1593
966	7559
966	794
966	1579
5413	5148
5413	2455
5413	1593
5413	7559
5413	794
5413	1579

This listing of possible pairings is compared with each of the permissible pairs (See Table I) for the first character stored in the storage buffer 62, and all of the possible pairs which are found in the list of permissible pairings are transferred to the significant pair storage buffer 124. In this case, it will be seen that the pair 966, 2455 is found in both places, and is stored in buffer 124. This is the only pair which appears in both lists.

The selector logic 90 determines that only a single pair is stored in buffer 124, and accordingly displays the characters represented by the index codes 966 and 2455; namely "dì fāng", the desired characters. Thus, all ambiguities have been resolved automatically, and the codes 966 and 2455 are entered in the text buffer 92.

The operation of the system in the phonetic mode, using the pinyin (romanized phonetic) system for identifying the characters to be typed, is essentially the same as in the shape recognition mode illustrated above. The only difference is that instead of using keyboard 10 to enter a shape identifier code, the keyboard 11 us used to enter the phonetic (pinyin) spelling of the character or characters to be typed, and the phonetic spelling provides the required identifier codes. The identifier codes then operate in the same manner as described above to call up all of the corresponding characters, and the index codes of the called-up characters are transferred to buffers 62 and 66. Thereafter, the matching network 120 pairs the index codes, and disambiguation proceeds as described above.

Although keyboards 10 and 11 can be used separately and a system can be produced in accordance with the invention having only one keyboard, numerous advantages may be derived from providing the two in parallel. With such an arrangement, the two keyboards can be interchangeably used without resorting to any sort of shift mechanism, and the system will operate as described above. Thus, for example, the word "di fang" can be identified in any of the following ways:

Shape recognition	4411, 955
Pinyin :	dì , fāng
Shape + pinyin	4411, fāng
Pinyin + shape	dì , 955

In the use of the present system, entry of any one of the above sets of identifiers would result in a display of the characters shown in Fig. 2.

Although the system and method of the invention have been described in terms of block diagram circuitry illustrating the structure and function of data processing circuitry capable of carrying out the concepts of the system, it will be understood that in one embodiment of the invention, the process may be carried out in a general purpose data processor appropriately

programmed to follow the procedures described above. It will, however, be apparent that special purpose circuitry may be constructed in accordance with the foregoing description to carry out the described method equally well. Numerous variations and modifications may be made in the illustrated system and in the program listing, such as adapting the system for use with symbolic languages other than Chinese such as Japanese or Korean, or permitting the use of the National Phonetic Alphabet (Zhuyin Fuhao), kana (for identification of kanji) or any of a number of other syllabaries or alphabets. If desired, the illustrated system and program can be revised to provide for the use of an occasional 5-stroke identifier for common, often-used words that would otherwise have to be disambiguated every time they occurred. These and other variations may be made by those of skill in the art, without departing from the true scope of the invention as set forth in the following claims.

Claims:

1. A method of producing ideographic text material utilizing a keyboard (10, 11) having a plurality of keys carrying indicia related to characters to be produced, characterized by the steps of selecting one or more of said keys in sequence to provide an identifier code for each desired character; calling up from a memory means character information representing all the characters corresponding to the identifier code produced by the keyboard for each desired character; temporarily storing said called-up character information; determining if a difference exists between the number of characters desired and the number of characters represented in the temporarily stored character information; resolving any resulting ambiguities; and transferring output information representing the desired character to a text storage means (36).

2. A method according to claim 1, wherein the indicia on said keys (Fig. 1A) correspond to shape recognition features of selected portions of characters to be produced, said step of selecting one or more of said keys providing for each desired character an identifier code corresponding to specified stroke configurations of the character.

3. A method according to claim 2, wherein said step of selecting one or more of said keys (Fig. 1A) includes selecting, for each quadrant containing a characteristic configuration of a character to be produced, one of said keys having the single indicia which most closely corresponds to the shape of said characteristic configuration, the selection of between one and four of said keys combining to produce the identifier code for that character.

4. A method according to claim 1, wherein the indicia on said keys (Fig. 1B) correspond to a phonetic alphabet, said step of selecting one or more of said keys in sequence effecting spelling

the phonetic pronunciation of each desired character, thereby providing the identifier code for such character.

5. A method according to claim 1, wherein said step of resolving any resulting ambiguities includes the steps of displaying sequentially each of the characters represented in the character information called up by said identifier code, and manually selecting the desired character from those displayed to determine said output information.

6. A method according to claim 5, wherein said step of manually selecting includes manually producing by using said keyboard (10 or 11) a control signal adapted to transfer said output information representing the desired character to said text storage means (36).

7. A method according to claim 1, for producing a desired pair of characters corresponding to a compound word, including: selecting one or more of said keys in sequence to provide a first identifier code for a first desired character; selecting one or more of said keys to provide a second identifier code for a second desired character; calling up from said memory means (32) first character information representing all the characters corresponding to said first identifier code; calling up from said memory means (32) a permissible pair list for each character corresponding to said first identifier code; calling up from said memory means (32) second character information representing all the characters corresponding to said second identifier code; matching each of the characters corresponding to said first identifier code with each of the characters corresponding to said second identifier code to produce a list of possible character pairs; determining whether an ambiguity exists between said possible pair list and said permissible pair list; and resolving any ambiguity.

8. A method according to claim 7, wherein the step of determining whether an ambiguity exists includes comparing said permissible pair list with said possible pair list to determine whether more than one character pair appears in both of said lists.

9. A method according to claim 8, wherein said step of determining whether an ambiguity exists includes the steps of storing in a significant pair storage means (124) all pairs which appear in both of said lists, displaying a first character pair stored in said significant pair storage means (124) to determine if it is said desired pair of characters, and if not, then displaying in sequence the remaining character pairs in said significant pair storage means (124) and selecting from the displayed character pairs the desired character pair.

10. A method according to any one of the preceding claims, including the step of printing the contents of said text storage means (36).

11. Apparatus for carrying out the method according to claim 1, including a keyboard (10, 11) having a plurality of keys carrying indicia related to characters to be produced, said memory means (32) being arranged to store a first list representing characters and a second list representing permitted character pairings, said characters and pairings being represented in said lists by index codes selectable by specified identifier codes whereby a selected identifier code will call up all the index codes and pairings of all characters corresponding to the selected identifier code.

12. Apparatus according to claim 11, including first storage means (62) arranged to receive the index codes and permitted pairings for a first identifier code corresponding to a first character

of a desired pair of characters; second storage means (66) arranged to receive the index codes and permitted pairings for a second identifier code corresponding to a second character of a desired pair of characters; matching means (120) arranged to match the index codes stored in said first storage means (62) with the index codes stored in said second storage means (66) to produce a list of possible character pairs; selection storage means (76); and coupling means (72) adapted to connect said selection storage means (76) selectively either to said first storage means (62) to receive and store only the index codes in said first storage means (62) for a single desired character or to said matching means (120) to receive said list of possible character pairings for a desired pair of characters.

Fig.1B

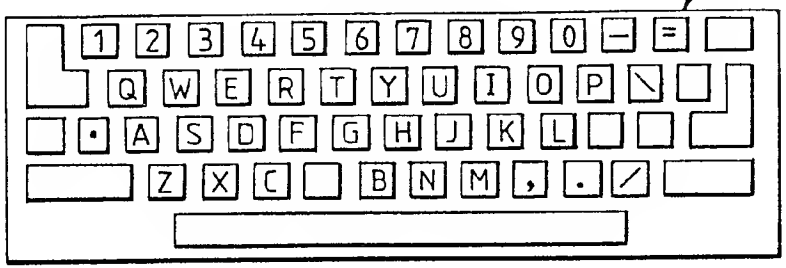


Fig.1A

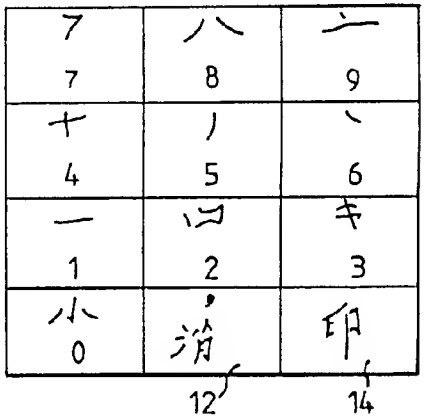


Fig.2

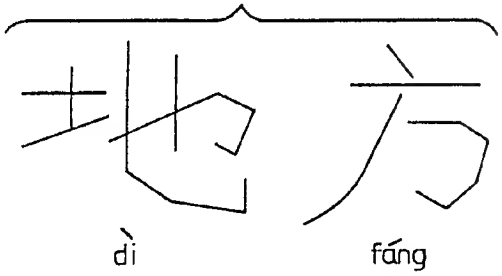
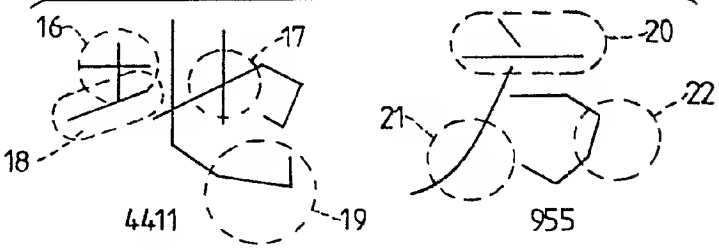


Fig.3



0028533

Fig.4a

Fig.4b

Fig.4c

Fig.4d

Fig.4e

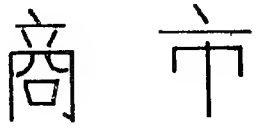


Fig.4f

Fig.5

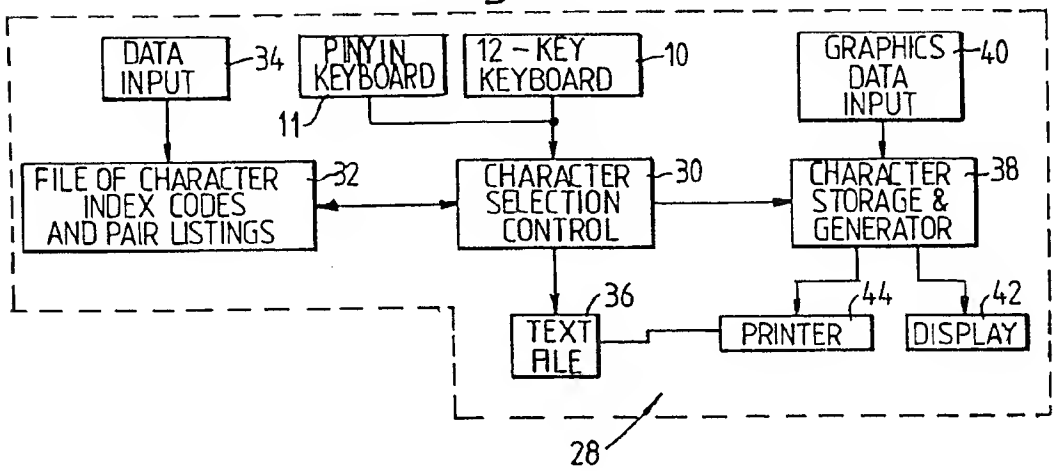
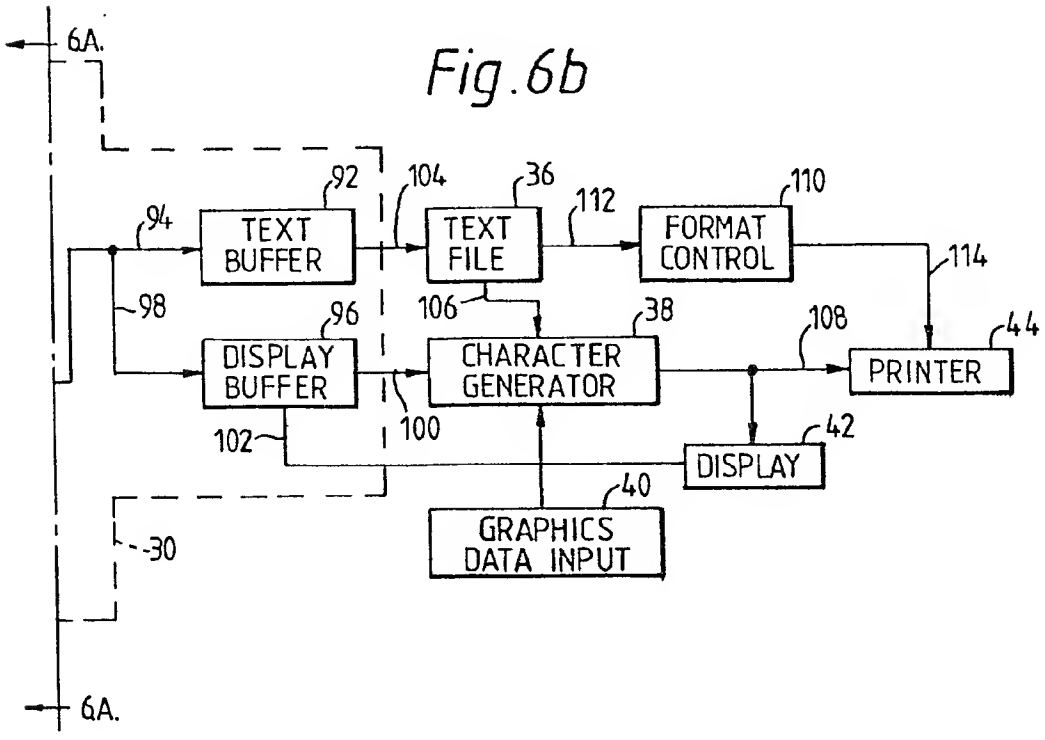


Fig.6b



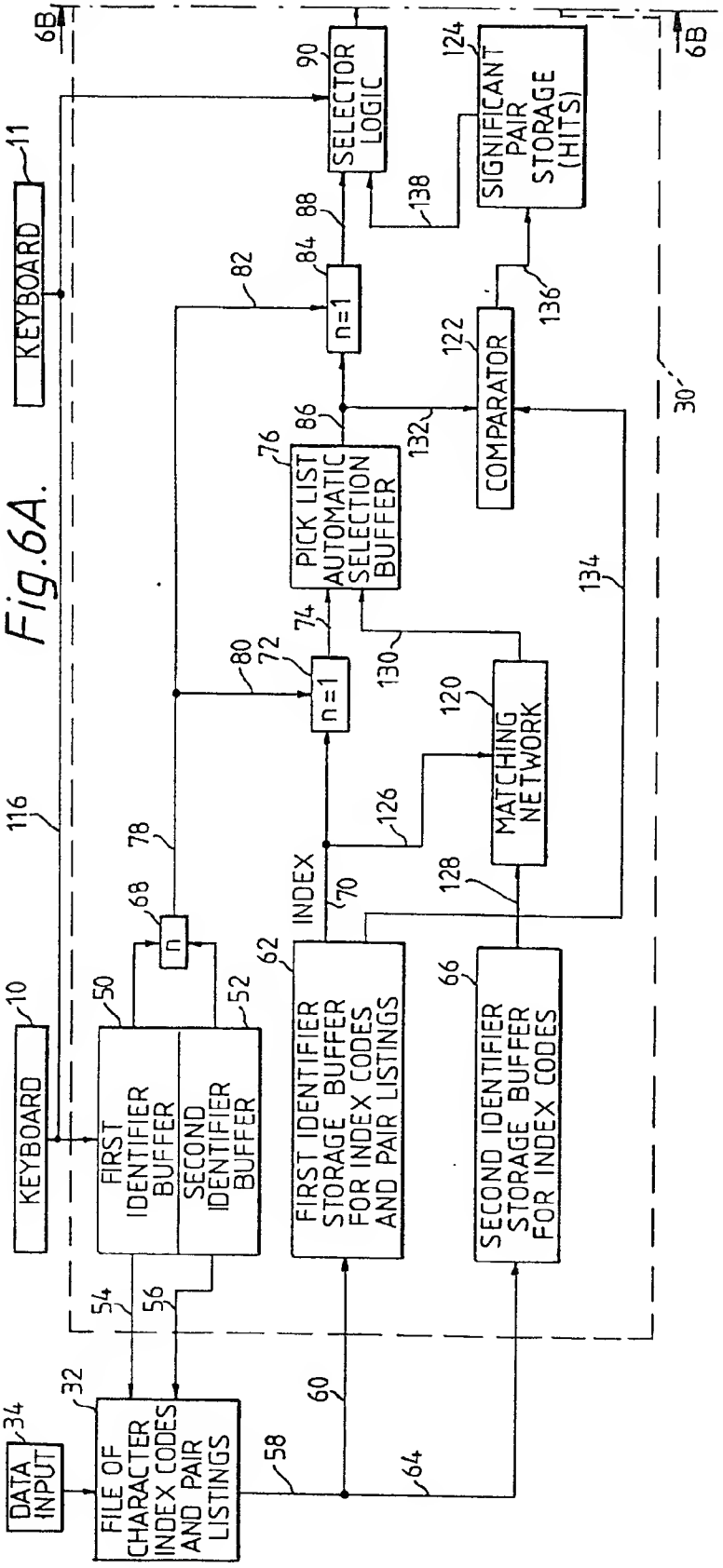


Fig.6A.

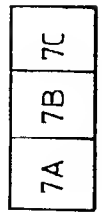


Fig.9.

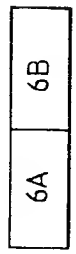


Fig.8.

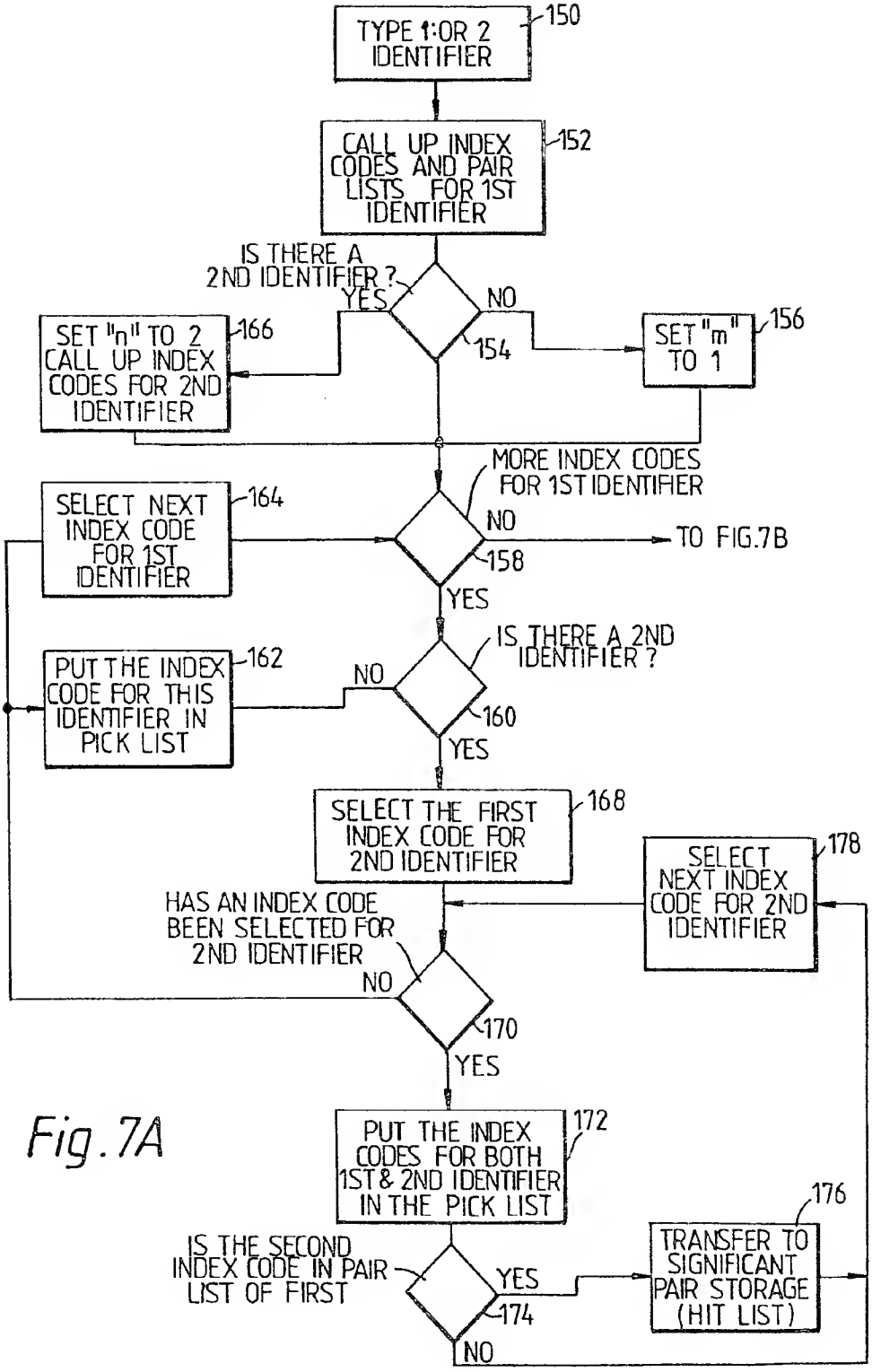

TYPE 1:OR 2 IDENTIFIER
150
CALL UP INDEX CODES AND PAIR LISTS FOR 1ST IDENTIFIER
152
IS THERE A 2ND IDENTIFIER?
YES
NO
154
SET "n" TO 2 CALL UP INDEX CODES FOR 2ND IDENTIFIER
166
SET "m" TO 1
156
MORE INDEX CODES FOR 1ST IDENTIFIER
SELECT NEXT INDEX CODE FOR 1ST IDENTIFIER
164
NO
TO FIG.7B
158
YES
IS THERE A 2ND IDENTIFIER?
PUT THE INDEX CODE FOR THIS IDENTIFIER IN PICK LIST
162
NO
160
YES
SELECT THE FIRST INDEX CODE FOR 2ND IDENTIFIER
168
SELECT NEXT INDEX CODE FOR 2ND IDENTIFIER
178
HAS AN INDEX CODE BEEN SELECTED FOR 2ND IDENTIFIER
NO
170
YES
PUT THE INDEX CODES FOR BOTH 1ST & 2ND IDENTIFIER IN THE PICK LIST
172
IS THE SECOND INDEX CODE IN PAIR LIST OF FIRST
YES
174
NO
TRANSFER TO SIGNIFICANT PAIR STORAGE (HIT LIST)
176

Fig. 7A

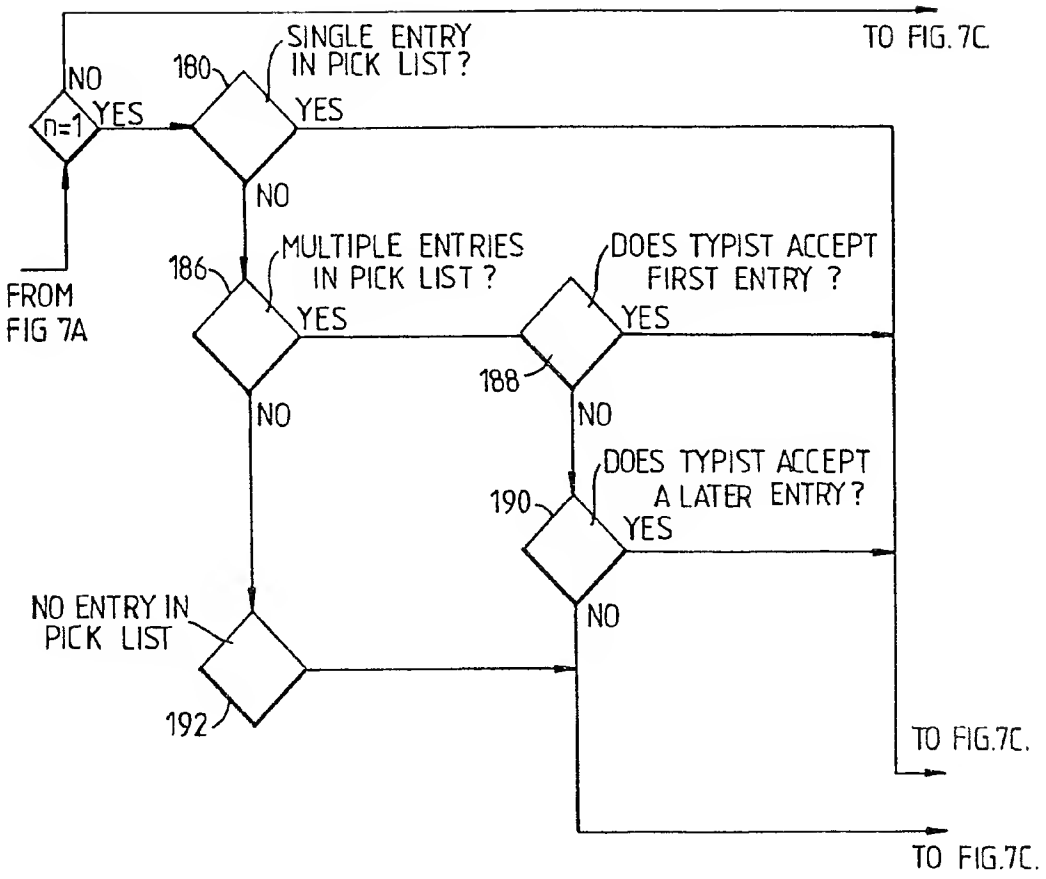

TO FIG. 7C
SINGLE ENTRY IN PICK LIST?
180
NO
n=1
YES
YES
NO
FROM FIG 7A
186
MULTIPLE ENTRIES IN PICK LIST ?
YES
DOES TYPIST ACCEPT FIRST ENTRY ?
YES
188
NO
NO
DOES TYPIST ACCEPT A LATER ENTRY?
190
YES
NO
NO ENTRY IN PICK LIST
192
TO FIG.7C.
TO FIG.7C.

Fig. 7B

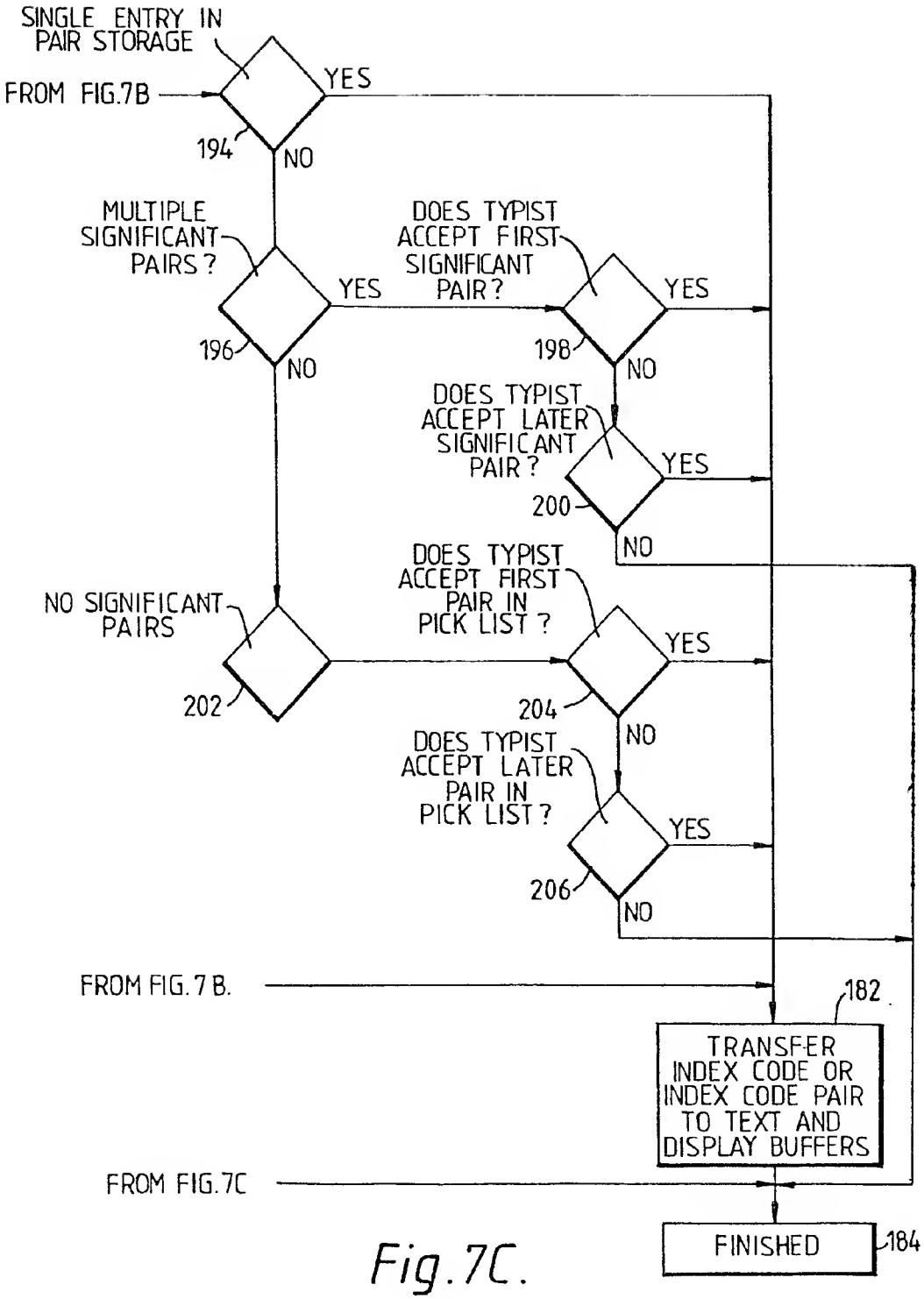

SINGLE ENTRY IN PAIR STORAGE
FROM FIG.7B
YES
194
NO
MULTIPLE SIGNIFICANT PAIRS?
YES
196
NO
DOES TYPIST ACCEPT FIRST SIGNIFICANT PAIR?
YES
198
NO
DOES TYPIST ACCEPT LATER SIGNIFICANT PAIR?
YES
200
NO
NO SIGNIFICANT PAIRS
202
DOES TYPIST ACCEPT FIRST PAIR IN PICK LIST?
YES
204
NO
DOES TYPIST ACCEPT LATER PAIR IN PICK LIST?
YES
206
NO
FROM FIG. 7 B.
182
TRANSFER INDEX CODE OR INDEX CODE PAIR TO TEXT AND DISPLAY BUFFERS
FROM FIG. 7C
FINISHED
184

Fig. 7C.